

I claim:

1. A catheter tip apparatus arranged in a catheter for the delivery and collection of an energy signal to permit subsequent light energy beam analysis of body tissue by the collected signal, comprising:

an elongated housing supporting a first reflective surface and a second reflective surface, said first reflective surface and said second reflective surface being longitudinally spaced apart from one another;

a first flexible, elongated energy bearing delivery fiber having a distalmost end arranged adjacent said first reflective surface;

a second flexible, elongated energy bearing collection fiber having a distalmost end arranged adjacent said second reflective surface; and

said housing rotatably supported on a flexible catheter sheath for insertion of said catheter into a mammalian body for tissue analysis thereof.

2. The catheter tip apparatus as recited in claim 1, wherein said housing comprises a frame member having a slot arranged therein for receipt and alignment of said first and said second reflective surfaces.
3. The catheter tip apparatus as recited in claim 1, wherein said first reflective surface and said second reflective surface each comprise a beam redirecting member.
4. The catheter tip apparatus as recited in claim 2, wherein said slot has shoulders therein to guideably secure and accurately align said reflective surfaces therein.
5. The catheter tip apparatus as recited in claim 2, wherein said housing has a proximalmost stem portion for receipt into a catheter sheath to permit manipulation of said tip from a proximal location.
6. The catheter tip apparatus as recited in claim 1, wherein said housing comprises a frame member having a proximal end and a distal end, with an upstanding proximal block and an upstanding

midblock, each block having a pocket thereadjacent for receipt of a reflective surface attachable therein.

7. The catheter tip apparatus as recited in claim 6, wherein said reflective surface comprises a mirror glued into ^{AB} said pocket.
8. The catheter tip apparatus as recited in claim 6, wherein each of said upstanding blocks has a bore therethrough for receipt of one of said energy bearing fibers.
9. The catheter tip apparatus as recited in claim 1, wherein said housing comprises an elongated generally cylindrically shaped frame member with a proximal end and a distal end, said frame member having at least two steps thereon of decreasing thickness in the distal direction, each of said steps having a reflective surface mounted thereon, said proximal end having a stem portion of reduced diameter to permit rotative receipt within a catheter sheath.
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10. The catheter tip apparatus as recited in claim 9, wherein said frame member has a cover member arranged to mate over said steps and said reflective surfaces.
11. The catheter tip apparatus as recited in claim 10, wherein said cover member has an axially arranged slot thereon through part of its longitudinal length, said slot being disposed radially adjacent each of said reflective surfaces to permit delivery and reflected collection of an energy beam therethrough.
12. The catheter tip apparatus as recited in claim 9, wherein said stem portion is secured to a multi-layered, elongated coil spring arrangement to permit twisting control of said catheter tip within a mammalian body component.
13. The catheter tip apparatus as recited in claim 1, wherein said reflective surfaces are unitary portions of said housing.

14. The catheter tip apparatus as recited in claim 13 wherein said housing has a proximal end and a distal end, and said proximal end mates with a housing enclosure, said enclosure providing a securement means for said energy collecting fiber and said housing provides a securement means for said delivery fiber.
15. The catheter tip apparatus as recited in claim 14, wherein said housing enclosure attached to said proximal end of said housing has a longitudinally directed elongated slot therein, said slot being in radial alignment with said reflective surfaces formed on said housing to permit transmission and collection of radiant energy via said respective reflective surfaces to a computerized analysis system.
16. The catheter tip apparatus as recited in claim 1, wherein said housing comprises a cylindrically shaped member having said first and second reflective surfaces machined thereon, and wherein said first and second reflective surfaces are non-parallel with respect to one another.

17. The catheter tip apparatus as recited in claim 16, wherein said first and second fibers are diametrically oppositely aligned with respect to one another about a longitudinal axis of rotation of said housing, to minimize eccentricity of rotation of said catheter housing during rotation of said housing in a body tissue.
18. The catheter tip apparatus as recited in claim 1, wherein said housing includes a reflective surface which is bendable to effect directional change of an energy beam reflecting therefrom.
19. The catheter tip apparatus as recited in claim 18, wherein said housing has accumulation components defining a fiber alignment slot for miniaturization of said tip.
20. A catheter tip apparatus arranged in a catheter for the delivery and collection of an energy signal to permit subsequent computerized analysis of body tissue by the collected signal, comprising:
 - an elongated housing having a longitudinal axis of rotation,
 - said housing having a first reflective surface disposed thereon;

a second reflective surface disposed on said housing distally of said first reflective surface and in axial alignment therewith; and

a first light conductive fiber in light-coupled communication with said first reflective surface and a second light conductive fiber in light-coupled communication with said second reflective surface, said first light conductive fiber in communication being in communication with a controlled analytical-light-generating source and said second light conductive fiber being in communication with a light-collection analysis device.

21. The catheter tip apparatus as recited in claim 20, wherein said first reflective surface is dimensionally larger than said second reflective surface.
22. The catheter tip apparatus as recited in claim 20, wherein said first reflective surface is curvilinear.
23. The catheter tip apparatus as recited in claim 20, wherein said first reflective surface is non-parallel with respect to said second reflective surface.

24. The catheter tip apparatus as recited in claim 20, wherein at least one of said first and second reflective surfaces are spaced apart from said light conductive fibers.
25. The catheter tip apparatus as recited in claim 20, wherein said first reflective surface is disposed radially within and spaced from the perimeter of said housing to permit a spreading of a light beam from said first reflective surface onto said body tissue.
26. The catheter tip apparatus as recited in claim 24, having an index matching fluid arranged between a distal end of said conductive fiber and said reflective surface.
27. The catheter tip apparatus as recited in claim 24, wherein said reflective surface is positioned in a holding pocket arranged in said housing.
28. The catheter tip apparatus as recited in claim 27, wherein said reflective surface comprises a mirrored member.



29. The catheter tip apparatus as recited in claim 27, wherein said holding pocket is utilized to align said reflective surface with respect to said housing.
30. The catheter tip apparatus as recited in claim 20, wherein said conductive light fibers are each individually arranged within a bore disposed within said housing.
31. The catheter tip apparatus as recited in claim 20, wherein said light delivery fibers are equally diametrically opposed about said axis of rotation of said housing to provide balance thereto and minimize eccentricity during rotation thereof.
32. The catheter tip apparatus as recited in claim 20, wherein said first reflective surface and said second reflective surface are disposed at an angle proportional to the numerical aperture of said first and second fibers, to yield a light beam with adjacent edges that are parallel to one another, to permit a distance independent delivery reflector-collector reflector separation.



33. A catheter tip apparatus arranged in a catheter for the delivery and collection of an energy signal to permit subsequent computerized analysis of body tissue by the collected signal, comprising:

an optically transparent sheath enclosed elongated housing having a longitudinal axis of rotation, said housing having a first reflective surface disposed thereon;

a second reflective surface disposed on said housing distally of said first reflective surface and in axial alignment therewith;

a first light conductive fiber in light coupled communication with said first reflective surface and a second light conductive fiber in light coupled communication with said second reflective surface, said first light conductive fiber in communication being in communication with a controlled analytical-light generating source and said second light conductive fiber being in communication with a light-collection analysis device; and

a generally curvilinear cover arranged to mate over a distal portion of said housing to enclose said reflective surfaces, said cover having at least one opening on an annular surface thereof to permit light delivery to said body tissue, and to permit light collection therethrough upon reflection from said body tissue.



34. The catheter tip apparatus as recited in claim 33, wherein at least one of said reflective surfaces comprises a mirrored member.
35. The catheter tip apparatus as recited in claim 34, wherein each of said light conductive fibers has a distal end arranged within said housing, and said at least one of said light conductive fibers is in abutting relationship with a non-reflective surface of said mirrored member.
36. The catheter tip apparatus as recited in claim 33, wherein at least one of said reflective surfaces is disposed in a holding pocket.
37. The catheter tip apparatus as recited in claim 36, wherein said reflective surface is secured in said holding pocket by an adhesive.
38. The catheter tip apparatus as recited in claim 33, wherein an index matching fluid is disposed about said reflective surfaces to minimize back reflections thereto, from said outer sheath.

39. A catheter tip apparatus arranged in a catheter for the delivery and collection of an energy signal to permit subsequent computerized analysis of body tissue by the collected signal, comprising:

an optically transparent sheath enclosed elongated housing having a longitudinal axis of rotation, said housing having a first reflective light delivery surface disposed thereon;

a first reflective light collection surface disposed on said housing distally of said first reflective light delivery surface and in axial alignment therewith;

a first light conductive fiber in light coupled communication with said first reflective light delivery surface and a second light conductive fiber in light coupled communication with said first reflective light collection surface, said first light conductive fiber in being in communication with a controlled analytical-light generating source and said second light conductive fiber being in communication with a light-collection analysis device; and

a second reflective light collection surface disposed on said housing distally of said first reflective light collection , said second reflective collection surface also in communication with said controlled analytical-light generating source and in axial alignment



therewith; said first and second reflective surfaces arranged to permit deep tissue light energy penetration and collection and analysis thereby.

40. The catheter tip apparatus as recited in claim 39, wherein said first and second light collection surfaces collect light emitted from a common light delivery source.

41. A method of delivering and collecting a tissue-striking light energy signal from a first light bearing member and adjacent delivery beam redirecting member and returning said light energy signal to a collection beam redirecting member adjacent a second light bearing member for analysis and tissue treatment, in a light bearing arrangement, including:

spacing said collection beam redirecting member distally of said delivery beam redirector member in a sheath enclosed elongated catheter housing tip, said housing having a longitudinal axis;

disposing said beam redirecting members at an angle with respect to said longitudinal axis of said elongated housing

proportional to a numerical aperture of said first and second energy fibers.

42. The method as recited in claim 41, including:

bathing said reflectors in an index matching fluid to minimize back reflection in said sheath enclosed housing.

43. The method as recited in claim 41, including:

directing said delivery light energy signal and said collection light energy signal so as to yield adjacent edges thereof that are parallel.

44. The method as recited in claim 41, including:

delivering and collecting light from common fibers in said light fiber bearing arrangement.

45. The method as recited in claim 41, wherein said numerical apertures for each of said beam redirectors are different from one another.



46.The method as recited in claim 41, wherein said beam redirectors are reflectors.

47.The method as recited in claim 41, wherein said beam bearing members comprise optical fibers.

48.The method as recited in claim 41, wherein said beam bearing members comprise waveguides.

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